2021 ASEE ANNUAL CONFERENCE
Virtual Meeting | July 26–29, 2021 | Pacific Daylight Time
Paper ID #32585

Pre-Service Teachers' Experiences Teaching Engineering to Elementary Students During the Time of COVID (Work in Progress)

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Introduction

This study examines the experiences of two pre-service teachers (PSTs) as they implement an engineering curriculum in their practicum field experience. Portraiture methodology was employed to frame the entire research process, from protocol development and data collection and analysis to presentation of the findings as an "aesthetic whole", or final story that captures the unique classroom contexts and processes faced by the PSTs [1]. This study is part of a larger project focused on increasing awareness and preparedness of youth to pursue engineering careers. The first portion of the project involved working with elementary pre and in-service teachers in rural communities to connect local funds of knowledge (FoK) with classroom curriculum [2]. Participating teachers attended a summer workshop focused on how to use ethnographic practices, photo journaling, and micro-computers to enhance engineering instruction in elementary classrooms. Each PST was paired with an in-service teacher to plan how to implement the summer workshop curriculum into their classroom the following fall. However, when the COVID-19 pandemic resurged in late summer, classroom implementation plans were drastically changed due to shifts from in-person learning to hybrid and fully online instruction. Each school took a different approach to teaching during the pandemic, resulting in very diverse methods of implementing the engineering curriculum into classroom practice.

Teaching During COVID

With the arrival of the COVID pandemic, PSTs are entering the world of education in a turbulent environment with schools put into "panic mode"[3]. They spent years learning traditional pedagogy and skill sets to succeed as educators in a pre-COVID world. Now, they, along with their mentors, must adapt to education in the COVID era and recognize that the knowledge and pedagogy to effectively teach online are different than those skills used for in-person contexts [4]. Concerns about transitions to virtual education have long been foreshadowed. Studies have found factors challenging smooth transitions to online education include the quality of course content, role changes and pedagogical transitions, relationships within the learning context, the need to develop new skill sets, and issues establishing social presence [5, 6]. These same factors are impacting online education in P-12 contexts. Despite a deep commitment to their students' success, teachers reported that they overwhelmingly struggled to reach and teach their students in what they labeled the "emergency instruction" that came with transitions during COVID [7].

The Study

This portraiture study documents the experiences of the PSTs working in two diverse settings – one in a completely virtual classroom and the other in a face to face classroom implementing social distancing protocols. The goal of the portraiture methodology was to build a narrative that describes the PSTs' experiences delivering an engineering curriculum in their practicum field experiences [8] during the COVID pandemic. The resurgence of COVID in late summer resulted in a shift to hybrid and fully online instruction, and the need to integrate approaches for which the PSTs were not prepared. Ultimately, the PSTs each adopted unique tactics to delivering the

engineering intervention. Little research exists on how the experiences of PSTs were altered by the pandemic. It would benefit teacher educators to have a deeper sense of how PSTs have responded to the constraints presented by COVID. In response to this gap, we used the following research question to frame our study: (1) What specific engineering education teaching strategies do elementary pre-service teachers integrate while practicing social distancing?

Methods

This study focuses on the experiences of two PSTs completing their practicum field experiences as part of their teacher education program. The teacher education program is situated within a large, public land grant university in the Rocky Mountain region. Both students are elementary education majors currently completing their practicum experiences in two local school districts. It should be noted that each PST has been given a pseudonym for this study. Each PST was provided a pre-built engineering curriculum that focused the integration of computer science, electrical engineering, and agriculture science to build soil moisture sensors and automatic watering systems. Given the role that ranching and farming plays in the state, this particular engineering curriculum was selected because the agriculture connection provided the most relevance to the greatest number of participating students.

We selected portraiture methodology, a type of qualitative narrative inquiry, to frame our investigation. Although quantitative data might provide one mechanism for comparing the PSTs experiences in the different contexts, portraiture is a qualitative methodology that was selected for this study because it can result in a rich story about the unique classroom contexts and processes faced by the PSTs in this study, as well as document the successes felt during their experiences [1]. Although portraiture methodology is not without its critiques, it was originally developed as a way of bridging science and art, coalescing ethnographic methods with storytelling and literature [8, 9]. It should be noted that portraiture is a unique methodology in that it can be used in comprehensive fashion to structure the entire research process, from protocol development to data collection and analysis to presentation of the findings. Another hallmark of the methodology is that portraiture emphasizes searching for “goodness” and highlighting successes [8, 10], telling a story about the participants that captures the voice of both the researcher and subjects. In other words, rather than studying the shortcomings and failures of the participants and sites beings studied, portraiture instead focuses on locating and describing “those moments of resistance and negotiation that ultimately lead to success”[11].

We framed our data analysis and resulting portrait generation with five suggested key features of a portraiture study[12]: (1) context, (2) voice, (3) relationship, (4) emergent themes, and (5) the aesthetic whole. To start, context is used to describe both internal and personal contexts, where internal context is the physical setting for the study, and personal context includes the reasons for the study, the data sources, and the personal perspectives we, the researchers, brought to the study [1]. Next, voice refers to how the experiences and words of both the participants and the researchers is communicated to the reader [11]. The voice dimension also includes a negotiation of the tension between taking an objective versus subjective stance, and understanding the implications of using “I” and “we” in a rigorous qualitative study [1]. Thirdly, portraiture includes recognition of the dynamic nature of relationships between participants and the researchers, and how authentic relationships are necessary to elicit authentic findings, and to gain

entrée and accurately portray participants' experiences [10]. Next, portraiture relies on the integration of a systematic and empirical approach to study the emergent themes to arrive at the final portrait. Data analysis in portraiture utilized approaches that honor the fidelity of all rigorous qualitative data collection and analysis strategies, including flexible and iterative design that includes sourcing evidence of trustworthiness like member checking and audit trails. The final feature of portraiture is the aesthetic whole, the final narrative rooted in the emergent themes [1]. These key elements of portraiture guided our efforts and will ultimately be used to shape the aesthetic whole, or final portraits of each Kristina and Jennifer's experiences as PSTs.

Multiple data sources were used to generate a portrait of each PSTs' experiences delivering the engineering curriculum during their practicum field experience. Data sources include initial interviews with the participating PSTs and their cooperating teachers, PSTs' field journals, videos of classroom implementation of the engineering curriculum, pre- and post-drawings representing PSTs' perceptions of engineering teaching, and PST surveys [13, 14].

Results: Portrait Summaries

Full portraits of each PSTs' experiences are currently being composed. Because data analysis is currently underway, and the generation of the final portraits is a substantive task, portrait summaries are provided below. Again, given the extensive nature of the data analysis necessary to compose a complete portrait, the following summaries are only brief snapshots of the full portraits we are currently developing to more completely detail each PSTs' experiences.

Kristina

Kristina, a senior elementary education major also working toward a science education option, was a strong student both in Author 1's educational technology course and Author 3's science methods course. She brought enthusiasm and energy to her coursework and was often seen as a leader among her peers during both small group and large group work. For her second of two practicum experiences, she was placed in a local 4th grade classroom close to the university she is attending, where she was eager to apply her training in elementary and science education. Holly, her cooperating teacher, is a National Board Certified Teacher with over 14 years of experience. Kristina was particularly excited to be a part of this project due to the STEM emphasis, as her career goals include teaching upper elementary or middle school science.

Although the school at which Kristina was placed opted to return to in-person learning in the fall, Kristina's cooperating teacher was selected to teach online for those 4th graders who were not able or not comfortable returning to face-to-face instruction. Kristina had not planned on completing her second practicum in an online and virtual context, but as expected, tackled the challenge with enthusiasm and excitement. Her cooperating teacher, Holly, is considered by many to be a technology leader in the school and across the district, and Kristina was eager to experience online teaching and learning under her guidance.

Kristina shared on several different occasions how much this experience impacted her thinking about science instruction and shared some notable impacts on her perceptions of engineering and how to best teach STEM content. Most importantly, Kristina's confidence in teaching

engineering increased considerably from the start of the project to the end. Although she was at first concerned about teaching STEM, especially under COVID constraints, she soon found passion for both teaching and learning STEM material. Because the engineering curriculum she delivered included considerable focus on computer science, and more specifically, in coding, she was exposed to a STEM discipline that really ignited her passion and validation for her chosen career. Simply put: This experience served as a career affirmation event that we want all PSTs to experience during their teacher education trajectory. Kristina also experienced the true power of collegial and collaborative relationships during her time in practicum. Holly routinely revisited the best-practice research in teaching with Kristina, and those conversations helped form the foundations of a powerful mentorship role Holly was able to play for Kristina.

Jennifer

Jennifer began her colleges career as an engineering major but switched to education her freshman year due to her desire to work with children. Like Kristina, Jennifer was a strong student in the previous courses she had taken with us, and brought a positive, creative, and thoughtful lens to the work she completed for class. Given her previous interests in engineering coupled with her addition of the science and math option to her elementary degree, we both knew she would be strong addition to our project. This was Jennifer's first of two total practicum experiences. Besides early field work or camp and tutor work, this first practicum experience is often a teacher education student's first substantive dive into the work of K-12 education.

Jennifer was placed in a small rural 3rd grade classroom with Kerri, a veteran teacher with almost 20 years of teaching experience. When we spoke to Kerri's administrator about possible participants in our project the summer before, Kerri's was the first teacher to come to mind. Kerri has extensive experience working with PSTs, as well as a keen interest in STEM learning, making her a perfect fit for a cooperating teacher under which Jennifer could train. Unlike Kristina, the school at which Jennifer was placed decided to return to full in-person learning in the fall at the start of her practicum experience. Jennifer shared that the 17 students in her class were very successful negotiating COVID protocols throughout the experience, including masking, washing hands, and social distancing. Under normal circumstances, Jennifer's cooperating teacher encouraged flexible seating. But Jennifer shared it took some getting used to for everyone, herself included, to manage the impact of social distancing on teaching strategies such as group work. Further, Jennifer was faced with a series of extenuating circumstances that resulted in her taking the primary lead on science instruction.

During her time delivering the engineering curriculum, Jennifer was able to lean into the strong relationship she developed with Kerri, her cooperating teacher. Like Kristina's experience with Holly, Jennifer found Kerri's expert guidance and mentorship critical to her successes during the practicum experience. Further, she saw considerable shifts to both her own perceptions of engineering, as well as her students' perceptions. She shared with us that she witnessed her students' ideas "expand" from considering engineering as physical manifestations, such as cars and cell phones, to engineering being about problem solving. She was also delighted that her students were able to see beyond the agriculture-focus of our engineering curriculum and apply the concepts addressed into other STEM realms. From a teaching and learning perspective, Jennifer learned quickly the importance of having a back-up plan as a teacher, and the need for

flexibility and the ability to pivot when things do not go as expected. The experience in Kerri's class also provided Jennifer an opportunity to practice scaffolding and differentiation in lesson design, two teaching practices we know often challenge our PSTs. Ultimately, like Kristina, Jennifer left the experience with a deep sense of career affirmation, thrilled about her future as an educator. Most importantly, she was certain that her love of science and engineering would continue to evolve into a cornerstone of her identity as an educator.

Discussion

The limitations presented at the onset of COVID were so overwhelming they shifted our research questions and subsequent methodology altogether. With only two PSTs under study, and each teaching in a different distanced model, the data gathered is only a glimpse into the world of strategies deployed and successes had during this time. Our interactions with Kristina and Jennifer during the school year happened online, diminishing the flow and comfort sometimes necessary for a person to fully expound on their experiences. Portraiture provides a lens to magnify the experiences shared by subjects, but only the information shared can be magnified. What our PSTs shared does illuminate implications for the field moving forward, namely, the power of portraiture to highlight transformative events amidst a sea of data and experience.

Although the portraits shared here are only summaries of the full portraits being constructed, they do provide a snapshot of the unique classroom contexts and processes both Jennifer and Kristina faced during their practicum experience. They experienced shifts in the way they conceptualized engineering teaching and learning. They were presented with unforeseen circumstances due to the pandemic that challenged their preconceptions and pushed their comfort with how they were trained to be teachers. They developed impactful relationships with their cooperating teachers and recognized the critical nature of the mentorship that Holly and Kerri provided each of them. And as a whole, the experience provided critical career affirmation for each of them, solidifying their interests in STEM education, but also provided reassurance that they were pursuing careers well-suited to who they were and their goals.

Despite the critiques of portraiture methodology found in the literature[9], it is our conclusion that the resulting portrait summaries from this study do serve as an example of how the methodology advances narrative inquiry, and provides an approach to bridging science and art. These summaries represent an intersection of ethnographic methods with storytelling and literature[8, 12], providing a unique lens into how the COVID pandemic has influenced these PSTs' experiences. Most importantly, and in the spirit of portraiture, the stories coming from this study highlight the "goodness" in teacher education, and the powerful nature relationships play in teaching and learning.

Acknowledgment

This material is based upon work supported by the National Science Foundation Research in the Formation of Engineers program under Grant Number EEC-1916673. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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